The Corrector

Iteration 3 Substep 2 **January 1997**

A NEWSLETTER FOR THE NPARC USERS ASSOCIATION

What's Inside

From the Support Team

The third major version of NPARC was released in mid-September and has been acquired by many of you in the NPARC user community. What do you think? Let us know your experiences. Both the UNIX and PC versions of the code have been widely distributed. Now you can run your NPARC applications on a PC. Be sure to read the article below on the PC version. We hope you have found the enhancements in block interface specification, dynamic memory and coarse-grain parallel operation worth the wait. An NPARC workshop was held in August to revalidate the alliance's vision and mission and to develop the "roadmap" for FY97 activities. See the lead article on the workshop written by our fearless leaders.

To let us know what you think or for support questions, the NPARC support team can be contacted at:

e-mail:
nparc-support@info.arnold.af.mil

phone:
(615)-454-7455

WWW:
http://info.arnold.af.mil/nparc

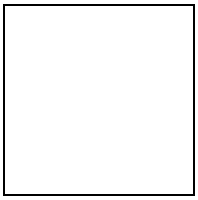
The Second NPARC Alliance Workshop

Jere Matty AEDC/Jai Shin LeRC

What do 22 people, five organizations, a zoo and legos have in common? All were involved in the Second NPARC Alliance Workshop held at the Arnold Engineering Development Center on 23-26 Aug 96.

The objectives of the three day workshop included revalidation of the alliance's vision and mission as well as the development of a roadmap for our activities in FY97. The "meeting" was hosted at the AEDC Gossick Leadership Center (GLC) and began with an exercise designed to bring out the plusses and minuses of the alliance from the perspective of the major partners: NASA LeRC, AEDC, and Industry.

The teams were then shuffled and engaged in a whimsical look at the alliance using a full range of metaphors from a zoo to an ocean (to include the identification of a few "sharks" in the water!). The vision and mission statements were then revisited with each team "building" the alliance from a batch of building materials to include legos and modeling clay. (See figure for a sampling of the artistic talents unearthed during this exercise…who says CFDers don't have a gift for the arts!). The day ended with a cookout on the deck of the GLC overlooking the scenic Woods reservoir.



The second day began with new team assignments and a futuristic look at the successful alliance in the year 2020, (to include the prediction of

Boeing buying McDonnell Douglas in the year 2000!) The major issues were then identified and self selected teams were formed to address them. The specifics were then captured on the morning of the third day and formed the draft of the FY97 Plans and Policy Document.

Overall the meeting was both fun and productive. We plan to hold one annually to keep the Alliance on track for the future.

NPARC: Now on a PC

There have always been a few renegade users who have insisted on running the NPARC code on their 33MHz 386 PC. Little did we know that within a few years the power of the UNIX workstation would be available to the PC user.

Previously, PC users had to make modifications to the code, mainly in I/O handling, in order to run effectively. Recently those changes have been made to the official version of NPARC.

The code itself is identical between the PC and UNIX versions. However, with the PC distribution, the user receives documentation in MS Word, rather than PostScript and the executables are available in addition to the source code.

Since most of us are UNIX weenies, the method of execution is currently similar to execution on a UNIX workstation. This can be frustrating for PC users who are used to drag and drop or nice file menus. We hope to improve the user interface in the future.

The major improvement over previous versions of NPARC for the PC is the addition of dynamic memory allocation. Thus, the code can be compiled once for any problem size, and we've already done it, if you don't want to bother with this step.

If any of you PC hackers develop a nice interface for the code, pass it on to us and we'll be sure to consider it for inclusion in the distribution.

Validation Activities

In its simplest form, validation is often considered to be a process of careful comparison of code results with trusted sources of information (e.g., benchmark data, analytical solutions, well excepted results from other codes, etc.). However, when viewed from the larger perspective of creating and reinforcing the overall credibility of code results, a validation activity really encompasses much more. Recently, AEDC hosted a Verification, Validation and Accreditation (VV&A) Workshop presented by Dr. Paul Muessig of the Naval Air Warfare Center, Weapons Division/China Lake, California and Mr. Dennis Laack, Computer Sciences Corporation, Camarillo, California. Dennis and Paul have been involved in the development of a cost effective VV&A process to support the growing emphasis on Modeling and Simulation (M&S) within DoD to support both acquisition and training. While their work, which is supported by the Joint Accreditation Support Activity (JASA), has focused primarily on the development of a VV&A process for high level M&S such as Theater / Campaign, Mission / Battle, and Engagement level models, their fundamental concepts are also applicable to the Engineering and Phenomenology level models such as NPARC. They have broken the VV&A process into the following three basic areas:

- **Model Overview - Are the basic characteristics of the model well known and documented?**

  Model Baseline Definition

  VV&A Status and Usage History

  Documentation Assessment

  Summary of Assumptions, Limitations and Errors

- **Functional Characterization - Are the functional characteristics of the model well-defined, well-designed and reasonable?**

  Functional Breakdown and Description

  Software Design Documentation

  Sensitivity Analysis

  Logical Verification Results

  Face Validation Results

- **Detailed V&V - Is the code built in accordance with the design? How well do model inputs and outputs compare with the real world?**

  Input Data VV&C

  Code Verification Results

  Validation Results

In future newsletter articles, we will discuss how each of the elements contributes to the generation and maintenance of credibility in code results, the ultimate goal of the validation effort.

As pointed out above, one of the fundamental elements of the VV&A activity remains the comparison of code results with trusted data sources. In that vein, the following discussion focuses on the progress to date in predicting the behavior of one of many fundamental flows of interest, the flow over a backward facing step.

This validation case is modeling the experiment described by David M. Driver and H. Lee Seegmiller in their paper, "Features of a Turbulent Shear Layer in Divergent Channel Flow" (AIAA Journal, Vol. 12, No. 2, 1985, pp.163-171). This problem is of interest because many applications in aeronautics have flows which separate and reattach. Predicting reattachment with CFD codes is difficult, yet often critical to accurately predicting the performance of, for example, aircraft engine inlets and nozzles.

Our goal in this validation study is to assess NPARC's ability to predict the flowfield in a separated region, as well as downstream of it. We are interested in the code's performance (in terms of how well it agrees with experimental data) and we are trying to determine the best way to use the code – primarily in terms of the input – for this problem.

Two factors that have a large effect on the quality of the solution are the turbulence model and the grid packing. Our validation work will include calculations made with several turbulence models, including the Chien k-epsilon and Wilcox k-omega two-equation models, and the Spalart-Almaras and Baldwin-Barth one-equation models. Cases will also be run on grids of various size and packing.

So far, a detailed calculation has been run using the Chien k-epsilon model. The resulting velocity profiles were predicted fairly well, except near the wall, where the shear stress was underpredicted in the separated region and overpredicted downstream of reattachment. Calculations were also made with two additional grids, one with 25% fewer grid points and one with 25% more grid points than the baseline grid. These results showed sensitivity to the number of grid points used.

As with other validation cases that have been run with NPARC, this case will be available, upon completion, on the NPARC validation archive in the form of a written document, along with the input files needed to run the individual cases and the corresponding output files. The URL for the NPARC validation archive is

http://info.arnold.af.mil/nparc/Archive_information.html

Development Update - Revolutionary Changes Envisioned

The NPARC Alliance has an ambitious vision to provide "The Computational Tool of Choice for Aerospace Flow Simulation." To realize this vision, the primary computational tool of the Alliance must meet the demanding needs of the CFD application engineers, i.e. ease of use, rapid turn-around, and accuracy for a wide variety of configurations and conditions. Until now, the NPARC code development has taken an evolutionary approach to meeting the users' needs.

This evolutionary approach has served the users and the Alliance well. However, an opportunity to make a revolutionary change to the primary flow solver has been offered to the Alliance. This opportunity is a result of at least two important events.

First, a single test and analysis contractor was chosen by the Air Force to replace the two contractor system at the Arnold Engineering Development Center. As a consequence, two independent CFD groups have merged, both with excellent flow simulation capability: the NPARC and XAIR codes. XAIR has been used for years to simulate external flow over complex bodies which move relative to one another, e.g. store separation. Recent developments have resulted in time-accurate store separation simulations with quite reasonable turn-around times.

Second, the McDonnell Douglas Aircraft Corporation has offered to provide much of its flow simulation technology to the NPARC Alliance in exchange for Alliance support and maintenance of the final code. The MDAC code, NASTD, has much of the same capability as both XAIR and NPARC. In addition, there are Graphical User Interface programs to aid the user in setting boundary conditions and interrogating the solution.

MDAC, AEDC and NASA Lewis Research Center have agreed to work together to combine the technologies of each of these codes to "leap frog" the development of the primary flow solver of the NPARC Alliance. The FY97 Plans and Policies document of the NPARC Alliance spells out the capabilities of the merged code and the schedule for executing the plan. Version 1 of the merged code is slated for release by the end of calendar year 1997.

The NPARC Alliance recognizes that the NPARC code, as it exists today, serves many users quite well. Thus, NPARC Version 3.0 will be supported and maintained for at least two years.

Bug fixes and minor modifications will be incorporated as required. In addition, the final version of the merged code is guaranteed to provide at least the current level of capability of each of the existing codes. However, if the list of capabilities is any indication, the merged code will be revolutionary indeed.

To all you acronym junkies: the merged code will consist of the best of the three existing codes, thus a new name will be required. Send your suggestions to

nparc-support@info.arnold.af.mil.

User Association Meetings

The 7th NPARC User's Association Meeting was held in conjunction with the AIAA/ASME/SAE/ASEE Joint Propulsion Conference during the July meeting in Lake Buena Vista, Florida. The gathering was attended by approximately 20 people and provided a forum for familiarizing new users with the Vision and Structure of the NPARC Alliance. In addition, a review of the status of the Support, Development, and Validation activities was also presented. The item receiving the greatest attention was the development and release of Version 3.0 which incorporates significant improvements including coarse grain parallelization, turbulence model enhancements, and improved block interfacing. In addition, the open forum discussions reiterated the user's desire for an integrated analysis system including surface/grid generation, flowfield computation and results analysis and display. This is an issue that the Alliance continues to work in conjunction with numerous pre- and postprocessor software vendors.

The following is a list of upcoming NPARC User's Association meetings:

June 23-25, 1997
AIAA Applied Aerodynamics Conference

Atlanta, GA

One NPARC Technical Session

NPARC User's Meeting

July 6-9, 1997
AIAA Joint Propulsion Conference
Seattle, WA

NPARC User's Meeting

January, 1998
AIAA Aerospace Sciences Meeting
Reno, NV

One NPARC Technical Session

NPARC User's Meeting

Please plan to attend one of the User's meeting to let your views be known. You are also encouraged to contribute to the NPARC technical sessions to communicate your experiences to other users.

Frequently Asked Questions

The following are some of the more frequently asked questions of the user support team.

Can I really run the NPARC code on a PC? What kind of FORTRAN compiler do I need?

Yes, the NPARC code really can run on a PC. The source code and an executable are distributed with the PC version in case you don't have a compiler. The executable was created using Microsoft FORTRAN Powerstation compiler version 4.0 under the Microsoft Windows 95 operating system. The dynamic memory option is used, so there is no need to change parameters and recompile for each problem.

Why do I get an end-of-file error when I try to run the k-epsilon turbulence model?

An extra record for the turbulence quantities is added to the restart file. You must either provide this information in the initial restart file or switch from an algebraic model to the transport equation model. Using the latter approach, the code will automatically generate reasonable turbulence quantities. See the User's Guide for more information.

Which boundary condition should I use for supersonic inflow?

The flow at a supersonic boundary does not change as solution progresses. Therefore, set the desired conditions in the restart file, then use the -10 boundary condition to freeze the conditions on the specified boundary. Currently, there is no provision to set these conditions directly as part of the boundary condition specification.

NOTES